

###Conduct a single factor ANOVA test with rating test

```
Sweetness.A <-c(5,3,7,5,7,4,8,8,3,5,7,8,8,5,7,9,7,5,6,5,5,3,8,7,3,8,8,6,6,2,4,4)
Sweetness.B <-c(8,8,8,9,8,6,9,8,6,6,8,3,6,6,8,7,7,3,8,5,5,6,7,4,7,8,9,7,7,6,7,8)
Sweetness.C <-c(5,6,6,4,5,4,7,6,4,6,6,5,5,3,3,9,4,3,3,6,7,2,4,4,8,7,3,4,4,3,2,5)
Sweetness.D <-c(6,7,8,8,7,7,8,6,7,5,8,6,6,4,7,8,4,5,8,7,4,5,6,4,9,7,6,5,7,4,7,7)
Sweetness.E <-c(5,5,7,3,6,2,7,4,4,6,7,4,5,4,7,8,8,3,4,4,3,3,4,7,4,7,5,4,5,8,2,4)
Sweetness.F <-c(6,7,6,7,8,5,9,8,6,5,7,4,8,7,6,7,8,7,8,6,5,8,7,4,6,8,8,7,7,7,7,8)
Sweetness.G <-c(3,3,4,9,4,3,8,5,3,4,3,6,5,1,4,8,2,1,5,4,7,5,8,7,3,6,6,6,5,4,6,5)
Sweetness.H <-c(3,7,4,5,6,7,8,5,6,7,7,6,7,6,7,8,8,3,9,8,1,2,6,4,8,7,8,8,7,7,6,7)
Sweetness.I <-c(3,6,8,7,5,4,7,7,5,6,6,6,7,5,3,9,8,3,6,4,8,7,7,7,8,7,4,5,7,3,3,4)
Sweetness.J <-c(7,7,8,7,8,7,9,7,6,6,8,5,7,4,6,9,6,1,8,6,6,4,8,3,7,7,8,6,7,7,8,9)
Sweetness.K <-c(3,2,7,4,5,3,8,6,6,6,4,4,6,1,4,8,5,2,3,4,5,4,8,6,3,6,5,4,3,5,2,3)
Sweetness.L <-c(8,6,8,8,7,4,8,4,7,6,7,3,6,6,3,8,8,4,8,6,5,6,6,3,6,7,8,7,6,6,7,8)
Sweetness.M <-c(3,4,4,7,5,4,7,5,3,4,7,2,6,2,2,8,7,2,3,5,4,2,8,7,5,4,7,6,3,3,4,4)
Sweetness.N <-c(6,7,8,9,8,6,9,7,6,7,8,3,7,4,6,9,7,8,7,6,5,8,7,4,6,7,8,7,7,7,7,8)
Sweetness.O <-c(6,7,7,4,5,4,8,4,4,7,5,2,5,3,4,7,5,2,3,2,7,3,6,8,2,4,4,4,5,4,4,6)
Sweetness.P <-c(8,4,8,5,8,5,9,4,4,4,6,3,7,6,7,8,7,4,7,6,3,7,8,4,7,7,6,7,6,4,5,7)
```

Attribute <-

```
c(Sweetness.A,Sweetness.B,Sweetness.C,Sweetness.D,Sweetness.E,Sweetness.F,Sweetness.G,
Sweetness.H,Sweetness.I,Sweetness.J,Sweetness.K,Sweetness.L,Sweetness.M,Sweetness.N,Sweetness.O,Sweetness.P)
```

```
Sweetness.A <- rep("A", times=32)
Sweetness.B <- rep("B", times=32)
Sweetness.C <- rep("C", times=32)
Sweetness.D <- rep("D", times=32)
Sweetness.E <- rep("E", times=32)
Sweetness.F <- rep("F", times=32)
Sweetness.G <- rep("G", times=32)
Sweetness.H <- rep("H", times=32)
Sweetness.I <- rep("I", times=32)
Sweetness.J <- rep("J", times=32)
Sweetness.K <- rep("K", times=32)
Sweetness.L <- rep("L", times=32)
Sweetness.M <- rep("M", times=32)
Sweetness.N <- rep("N", times=32)
Sweetness.O <- rep("O", times=32)
Sweetness.P <- rep("P", times=32)
Sweetness<-
```

```
factor(c(Sweetness.A,Sweetness.B,Sweetness.C,Sweetness.D,Sweetness.E,Sweetness.F,Sweetness.G,
Sweetness.H,Sweetness.I,Sweetness.J,Sweetness.K,Sweetness.L,Sweetness.M,Sweetness.N,Sweetness.O,Sweetness.P))
Assessors <- factor(rep(c(1:32), times=16))
```

```
results <-
data.frame(Sweetness=factor(Sweetness),Assessors=factor(Assessors),Attribute=Attribute)
results
```

```
library(asbio)
tukey.add.test(results$Attribute,results$Sweetness,results$Assessors)
```

```
#####
```

Tukey's one df test for additivity

data: results\$Sweetness and results\$Assessors on results\$Attribute
F = 1.4705, num.df = 1, denom.df = 464, p-value = 0.2259

```
#####
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```
preference.aov <- aov(Attribute~Sweetness+Assessors,results)
summary(preference.aov)
```

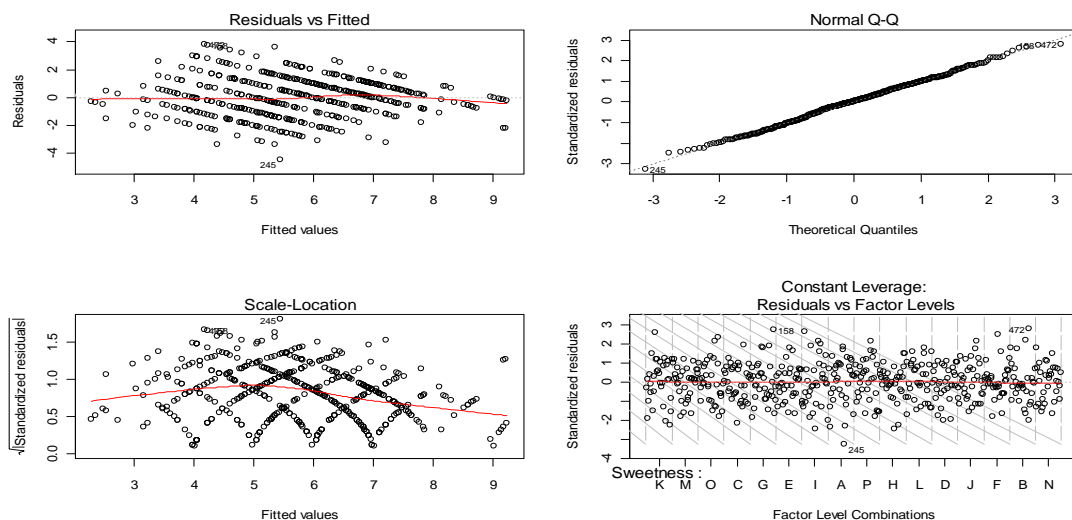
```
#####
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	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Sweetness	15	363.87	24.2582	11.7142	< 2.2e-16 ***
Assessors	31	500.59	16.1481	7.7979	< 2.2e-16 ***
Residuals	465	962.94	2.0708		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```
#####
```

```
aov(Attribute ~ Sweetness + Assessors)
```



###Conduct a 2k factorial design

```
>rep(c(rep(c(-1),times=8),rep(c(1),times=8))),times=32)
```

```

> B<-rep(rep(c(rep(c(-1),times=4),rep(c(1),times=4)),times=2),times=32)
> C<-rep(rep(rep(c(-1,-1,1,1),times=2),times=2),times=32)
> D<-rep(rep(rep(c(-1,1),times=4),times=2),times=32)
> level.design<-data.frame(A=factor(A),B=factor(B),C=factor(C),D=factor(D))
> level.design

```

	A	B	C	D
1	-1	-1	-1	-1
2	-1	-1	-1	1
3	-1	-1	1	-1
4	-1	-1	1	1
5	-1	1	-1	-1
6	-1	1	-1	1
7	-1	1	1	-1
8	-1	1	1	1
9	1	-1	-1	-1
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12	1	-1	1	1
13	1	1	-1	-1
14	1	1	-1	1
15	1	1	1	-1
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> Percent.sugar<-rep(c(rep(c(6),times=8),rep(c(15),times=8)),times=32)
> Ratio.yoghurt<-rep(rep(c(rep(c(7.2),times=4),rep(c(36.5),times=4)),times=2),times=32)
> Percent.kiwi<-rep(rep(rep(c(8,8,15,15),times=2),times=2),times=32)
> Percent.water<-rep(rep(rep(c(13,34),times=4),times=2),times=32)
> R1<-c(5,8,5,6,5,6,3,3,3,7,3,8,3,6,6,8)
> R2<-c(3,8,6,7,5,7,3,7,6,7,2,6,4,7,7,4)
> R3<-c(7,8,6,8,7,6,4,4,8,8,7,8,4,8,7,8)
> R4<-c(5,9,4,8,3,7,9,5,7,7,4,8,7,9,4,5)
> R5<-c(7,8,5,7,6,8,4,6,5,8,5,7,5,8,5,8)

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> R6<-c(4,6,4,7,2,5,3,7,4,7,2,4,4,6,4,5)
> R7<-c(8,9,7,8,7,9,8,8,7,9,8,8,7,9,8,9)
> R8<-c(8,8,6,6,4,8,5,5,7,7,6,4,5,7,4,4)
> R9<-c(3,6,4,7,4,6,3,6,5,6,6,7,3,6,4,4)
> R10<-c(6,6,6,5,6,5,4,7,6,6,6,6,4,7,7,4)
> R11<-c(7,8,6,8,7,7,3,7,6,8,4,7,7,8,5,6)
> R12<-c(8,3,5,6,4,4,6,6,6,5,4,3,2,3,2,3)
> R13<-c(8,6,5,6,5,8,5,7,7,7,6,6,6,7,5,7)
> R14<-c(5,5,3,4,4,7,1,6,5,4,1,6,2,4,3,6)
> R15<-c(7,6,3,7,7,6,4,7,3,6,4,3,2,6,4,7)
> R16<-c(9,8,9,8,8,7,8,8,9,9,8,8,8,9,7,8)
> R17<-c(7,7,4,4,8,8,2,8,8,6,5,8,7,7,5,7)
> R18<-c(5,3,3,5,3,7,1,3,3,1,2,4,2,8,2,4)
> R19<-c(6,8,3,8,4,8,5,9,6,8,3,8,3,7,3,7)
> R20<-c(5,5,6,7,4,6,4,8,4,6,4,6,5,6,2,6)
> R21<-c(5,5,2,4,3,5,7,1,7,6,5,5,4,5,7,3)
> R22<-c(3,6,7,5,3,8,5,2,7,4,4,6,2,8,3,7)
> R23<-c(8,7,4,6,4,7,8,6,7,8,8,6,8,7,6,8)
> R24<-c(7,4,4,4,7,4,7,4,7,3,6,3,7,4,8,4)
> R25<-c(3,7,8,9,4,6,3,8,8,8,3,6,5,6,2,7)
> R26<-c(8,8,7,7,7,8,6,7,7,7,6,7,4,7,4,7)
> R27<-c(8,9,3,6,5,8,6,8,4,8,8,7,8,4,6,6)
> R28<-c(6,7,4,5,4,7,6,8,5,6,4,7,6,7,4,7)
> R29<-c(6,7,4,7,5,7,5,7,7,7,3,6,3,7,5,6)
> R30<-c(2,6,3,4,8,7,4,7,3,7,5,6,3,7,4,4)
> R31<-c(4,7,2,7,2,7,6,7,3,8,2,7,4,7,4,5)
> R32<-c(4,8,5,7,4,8,5,9,4,9,3,8,4,8,3,7)
>
response<-c(R1,R2,R3,R4,R5,R6,R7,R8,R9,R10,R11,R12,R13,R14,R15,R16,R17,R18,R19,R20,R21,R
22,R23,R24,R25,R26,R27,R28,R29,R30,R31,R32)
>
design<-data.frame(Percent.sugar=factor(Percent.sugar),Ratio.yoghurt=factor(Ratio.yoghurt),Perc
ent.kiwi=factor(Percent.kiwi),Percent.water=factor(Percent.water),response)
> design

```

	Percent.sugar	Ratio.yoghurt	Percent.kiwi	Percent.water	response
1	6	7.2	8	13	5
2	6	7.2	8	34	8
3	6	7.2	15	13	5
4	6	7.2	15	34	6
5	6	36.5	8	13	5
6	6	36.5	8	34	6
7	6	36.5	15	13	3
8	6	36.5	15	34	3
9	15	7.2	8	13	3

10	15	7.2	8	34	7
11	15	7.2	15	13	3
12	15	7.2	15	34	8
13	15	36.5	8	13	3
14	15	36.5	8	34	6
15	15	36.5	15	13	6
16	15	36.5	15	34	8
17	6	7.2	8	13	3
18	6	7.2	8	34	8
19	6	7.2	15	13	6
20	6	7.2	15	34	7
21	6	36.5	8	13	5
22	6	36.5	8	34	7
23	6	36.5	15	13	3
24	6	36.5	15	34	7
25	15	7.2	8	13	6
26	15	7.2	8	34	7
27	15	7.2	15	13	2
28	15	7.2	15	34	6
29	15	36.5	8	13	4
30	15	36.5	8	34	7
31	15	36.5	15	13	7
32	15	36.5	15	34	4
33	6	7.2	8	13	7
34	6	7.2	8	34	8
35	6	7.2	15	13	6
36	6	7.2	15	34	8
37	6	36.5	8	13	7
38	6	36.5	8	34	6
39	6	36.5	15	13	4
40	6	36.5	15	34	4
41	15	7.2	8	13	8
42	15	7.2	8	34	8
43	15	7.2	15	13	7
44	15	7.2	15	34	8
45	15	36.5	8	13	4
46	15	36.5	8	34	8
47	15	36.5	15	13	7
48	15	36.5	15	34	8
49	6	7.2	8	13	5
50	6	7.2	8	34	9
51	6	7.2	15	13	4
52	6	7.2	15	34	8
53	6	36.5	8	13	3

54	6	36.5	8	34	7
55	6	36.5	15	13	9
56	6	36.5	15	34	5
57	15	7.2	8	13	7
58	15	7.2	8	34	7
59	15	7.2	15	13	4
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61	15	36.5	8	13	7
62	15	36.5	8	34	9
63	15	36.5	15	13	4
64	15	36.5	15	34	5
65	6	7.2	8	13	7
66	6	7.2	8	34	8
67	6	7.2	15	13	5
68	6	7.2	15	34	7
69	6	36.5	8	13	6
70	6	36.5	8	34	8
71	6	36.5	15	13	4
72	6	36.5	15	34	6
73	15	7.2	8	13	5
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75	15	7.2	15	13	5
76	15	7.2	15	34	7
77	15	36.5	8	13	5
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79	15	36.5	15	13	5
80	15	36.5	15	34	8
81	6	7.2	8	13	4
82	6	7.2	8	34	6
83	6	7.2	15	13	4
84	6	7.2	15	34	7
85	6	36.5	8	13	2
86	6	36.5	8	34	5
87	6	36.5	15	13	3
88	6	36.5	15	34	7
89	15	7.2	8	13	4
90	15	7.2	8	34	7
91	15	7.2	15	13	2
92	15	7.2	15	34	4
93	15	36.5	8	13	4
94	15	36.5	8	34	6
95	15	36.5	15	13	4
96	15	36.5	15	34	5
97	6	7.2	8	13	8

98	6	7.2	8	34	9
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101	6	36.5	8	13	7
102	6	36.5	8	34	9
103	6	36.5	15	13	8
104	6	36.5	15	34	8
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106	15	7.2	8	34	9
107	15	7.2	15	13	8
108	15	7.2	15	34	8
109	15	36.5	8	13	7
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116	6	7.2	15	34	6
117	6	36.5	8	13	4
118	6	36.5	8	34	8
119	6	36.5	15	13	5
120	6	36.5	15	34	5
121	15	7.2	8	13	7
122	15	7.2	8	34	7
123	15	7.2	15	13	6
124	15	7.2	15	34	4
125	15	36.5	8	13	5
126	15	36.5	8	34	7
127	15	36.5	15	13	4
128	15	36.5	15	34	4
129	6	7.2	8	13	3
130	6	7.2	8	34	6
131	6	7.2	15	13	4
132	6	7.2	15	34	7
133	6	36.5	8	13	4
134	6	36.5	8	34	6
135	6	36.5	15	13	3
136	6	36.5	15	34	6
137	15	7.2	8	13	5
138	15	7.2	8	34	6
139	15	7.2	15	13	6
140	15	7.2	15	34	7
141	15	36.5	8	13	3

142	15	36.5	8	34	6
143	15	36.5	15	13	4
144	15	36.5	15	34	4
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147	6	7.2	15	13	6
148	6	7.2	15	34	5
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150	6	36.5	8	34	5
151	6	36.5	15	13	4
152	6	36.5	15	34	7
153	15	7.2	8	13	6
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165	6	36.5	8	13	7
166	6	36.5	8	34	7
167	6	36.5	15	13	3
168	6	36.5	15	34	7
169	15	7.2	8	13	6
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171	15	7.2	15	13	4
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173	15	36.5	8	13	7
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212	6	7.2	15	34	4
213	6	36.5	8	13	4
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217	15	7.2	8	13	5
218	15	7.2	8	34	4
219	15	7.2	15	13	1
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222	15	36.5	8	34	4
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277	6	36.5	8	13	3
278	6	36.5	8	34	7
279	6	36.5	15	13	1
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287	15	36.5	15	13	2
288	15	36.5	15	34	4
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331	15	7.2	15	13	5
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336	15	36.5	15	34	3
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347	15	7.2	15	13	4
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444	15	7.2	15	34	7
445	15	36.5	8	13	6
446	15	36.5	8	34	7
447	15	36.5	15	13	4
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460	15	7.2	15	34	6
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482	6	7.2	8	34	7
483	6	7.2	15	13	2
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490	15	7.2	8	34	8
491	15	7.2	15	13	2
492	15	7.2	15	34	7
493	15	36.5	8	13	4

494	15	36.5	8	34	7
495	15	36.5	15	13	4
496	15	36.5	15	34	5
497	6	7.2	8	13	4
498	6	7.2	8	34	8
499	6	7.2	15	13	5
500	6	7.2	15	34	7
501	6	36.5	8	13	4
502	6	36.5	8	34	8
503	6	36.5	15	13	5
504	6	36.5	15	34	9
505	15	7.2	8	13	4
506	15	7.2	8	34	9
507	15	7.2	15	13	3
508	15	7.2	15	34	8
509	15	36.5	8	13	4
510	15	36.5	8	34	8
511	15	36.5	15	13	3
512	15	36.5	15	34	7

>

```
design.aov<-aov(response~Percent.sugar*Ratio.yoghurt*Percent.kiwi*Percent.water,data=design
)
```

```
> summary(design.aov)
```

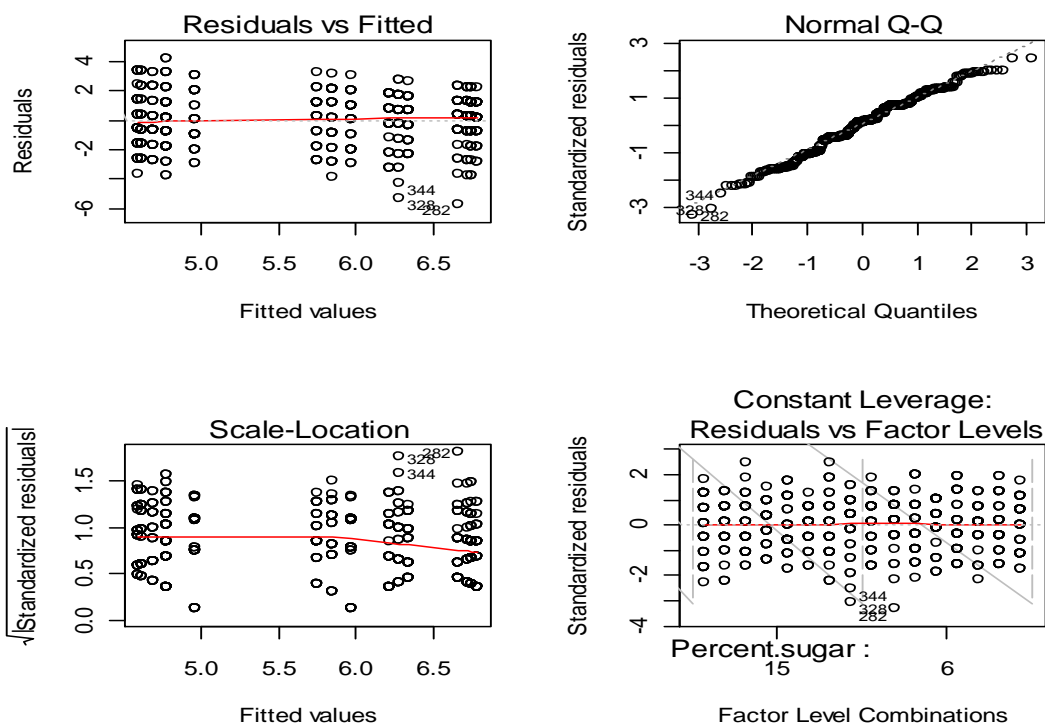
	Df	Sum Sq	Mean Sq
Percent.sugar	1	3.45	3.445
Ratio.yoghurt	1	9.03	9.031
Percent.kiwi	1	39.38	39.383
Percent.water	1	273.20	273.195
Percent.sugar:Ratio.yoghurt	1	0.20	0.195
Percent.sugar:Percent.kiwi	1	0.03	0.031
Ratio.yoghurt:Percent.kiwi	1	5.70	5.695
Percent.sugar:Percent.water	1	0.03	0.031
Ratio.yoghurt:Percent.water	1	5.70	5.695
Percent.kiwi:Percent.water	1	0.13	0.125
Percent.sugar:Ratio.yoghurt:Percent.kiwi	1	0.03	0.031
Percent.sugar:Ratio.yoghurt:Percent.water	1	0.00	0.000
Percent.sugar:Percent.kiwi:Percent.water	1	0.38	0.383
Ratio.yoghurt:Percent.kiwi:Percent.water	1	12.50	12.500
Percent.sugar:Ratio.yoghurt:Percent.kiwi:Percent.water	1	0.63	0.633
Residuals	496	1499.50	3.023
	F value	Pr(>F)	
Percent.sugar	1.1396	0.2862499	
Ratio.yoghurt	2.9873	0.0845408	.
Percent.kiwi	13.0269	0.0003382	***

Percent.water	90.3667 < 2.2e-16 ***
Percent.sugar:Ratio.yoghurt	0.0646 0.7994658
Percent.sugar:Percent.kiwi	0.0103 0.9190597
Ratio.yoghurt:Percent.kiwi	1.8839 0.1705144
Percent.sugar:Percent.water	0.0103 0.9190597
Ratio.yoghurt:Percent.water	1.8839 0.1705144
Percent.kiwi:Percent.water	0.0413 0.8389528
Percent.sugar:Ratio.yoghurt:Percent.kiwi	0.0103 0.9190597
Percent.sugar:Ratio.yoghurt:Percent.water	0.0000 1.0000000
Percent.sugar:Percent.kiwi:Percent.water	0.1266 0.7221081
Ratio.yoghurt:Percent.kiwi:Percent.water	4.1347 0.0425441 *
Percent.sugar:Ratio.yoghurt:Percent.kiwi:Percent.water	0.2093 0.6475014
Residuals	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```
oldpar<-par(oma=c(0,0,3,0),mfrow=c(2,2))
plot(design.aov)
par(oldpar)
```

spouse ~ Percent.sugar * Ratio.yoghurt * Percent.kiwi * Percent.w

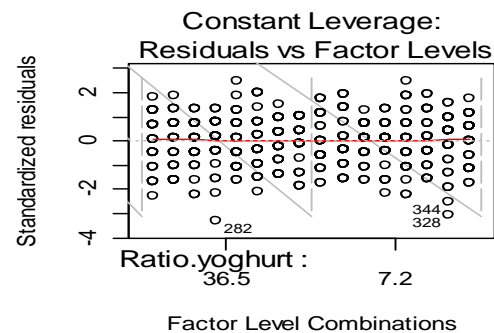
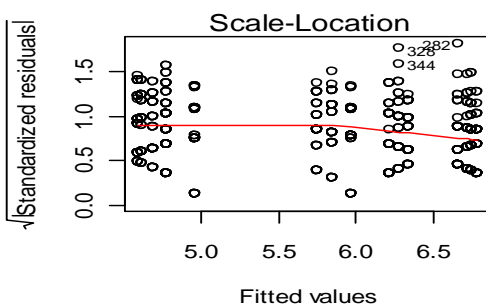
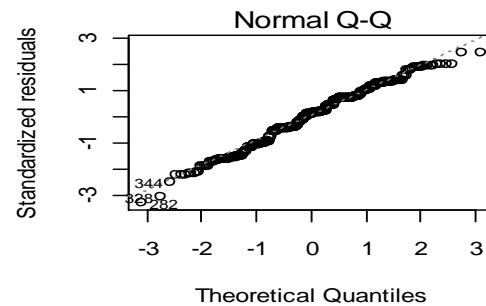
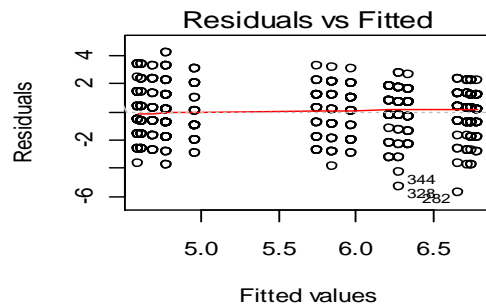


```
design.aov<-aov(response~Ratio.yoghurt*Percent.kiwi*Percent.water*Percent.sugar,data=design
)
> summary(design.aov)
```

	Df	Sum Sq	Mean Sq
Ratio.yoghurt	1	9.03	9.031
Percent.kiwi	1	39.38	39.383
Percent.water	1	273.20	273.195
Percent.sugar	1	3.45	3.445
Ratio.yoghurt:Percent.kiwi	1	5.70	5.695
Ratio.yoghurt:Percent.water	1	5.70	5.695
Percent.kiwi:Percent.water	1	0.13	0.125
Ratio.yoghurt:Percent.sugar	1	0.20	0.195
Percent.kiwi:Percent.sugar	1	0.03	0.031
Percent.water:Percent.sugar	1	0.03	0.031
Ratio.yoghurt:Percent.kiwi:Percent.water	1	12.50	12.500
Ratio.yoghurt:Percent.kiwi:Percent.sugar	1	0.03	0.031
Ratio.yoghurt:Percent.water:Percent.sugar	1	0.00	0.000
Percent.kiwi:Percent.water:Percent.sugar	1	0.38	0.383
Ratio.yoghurt:Percent.kiwi:Percent.water:Percent.sugar	1	0.63	0.633
Residuals	496	1499.50	3.023
		F value	Pr(>F)
Ratio.yoghurt		2.9873	0.0845408 .
Percent.kiwi		13.0269	0.0003382 ***
Percent.water		90.3667	< 2.2e-16 ***
Percent.sugar		1.1396	0.2862499
Ratio.yoghurt:Percent.kiwi		1.8839	0.1705144
Ratio.yoghurt:Percent.water		1.8839	0.1705144
Percent.kiwi:Percent.water		0.0413	0.8389528
Ratio.yoghurt:Percent.sugar		0.0646	0.7994658
Percent.kiwi:Percent.sugar		0.0103	0.9190597
Percent.water:Percent.sugar		0.0103	0.9190597
Ratio.yoghurt:Percent.kiwi:Percent.water		4.1347	0.0425441 *
Ratio.yoghurt:Percent.kiwi:Percent.sugar		0.0103	0.9190597
Ratio.yoghurt:Percent.water:Percent.sugar		0.0000	1.0000000
Percent.kiwi:Percent.water:Percent.sugar		0.1266	0.7221081
Ratio.yoghurt:Percent.kiwi:Percent.water:Percent.sugar		0.2093	0.6475014
Residuals			

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

response ~ Ratio.yoghurt * Percent.kiwi * Percent.water * Percent.su



>

```
design.aov<-aov(response~Percent.kiwi*Percent.water*Percent.sugar*Ratio.yoghurt,data=design
)
```

```
> summary(design.aov)
```

	Df	Sum Sq	Mean Sq
Percent.kiwi	1	39.38	39.383
Percent.water	1	273.20	273.195
Percent.sugar	1	3.45	3.445
Ratio.yoghurt	1	9.03	9.031
Percent.kiwi:Percent.water	1	0.13	0.125
Percent.kiwi:Percent.sugar	1	0.03	0.031
Percent.water:Percent.sugar	1	0.03	0.031
Percent.kiwi:Ratio.yoghurt	1	5.70	5.695
Percent.water:Ratio.yoghurt	1	5.70	5.695
Percent.sugar:Ratio.yoghurt	1	0.20	0.195
Percent.kiwi:Percent.water:Percent.sugar	1	0.38	0.383
Percent.kiwi:Percent.water:Ratio.yoghurt	1	12.50	12.500
Percent.kiwi:Percent.sugar:Ratio.yoghurt	1	0.03	0.031
Percent.water:Percent.sugar:Ratio.yoghurt	1	0.00	0.000
Percent.kiwi:Percent.water:Percent.sugar:Ratio.yoghurt	1	0.63	0.633
Residuals	496	1499.50	3.023
		F value	Pr(>F)

Percent.kiwi	13.0269 0.0003382 ***
Percent.water	90.3667 < 2.2e-16 ***
Percent.sugar	1.1396 0.2862499
Ratio.yoghurt	2.9873 0.0845408 .
Percent.kiwi:Percent.water	0.0413 0.8389528
Percent.kiwi:Percent.sugar	0.0103 0.9190597
Percent.water:Percent.sugar	0.0103 0.9190597
Percent.kiwi:Ratio.yoghurt	1.8839 0.1705144
Percent.water:Ratio.yoghurt	1.8839 0.1705144
Percent.sugar:Ratio.yoghurt	0.0646 0.7994658
Percent.kiwi:Percent.water:Percent.sugar	0.1266 0.7221081
Percent.kiwi:Percent.water:Ratio.yoghurt	4.1347 0.0425441 *
Percent.kiwi:Percent.sugar:Ratio.yoghurt	0.0103 0.9190597
Percent.water:Percent.sugar:Ratio.yoghurt	0.0000 1.0000000
Percent.kiwi:Percent.water:Percent.sugar:Ratio.yoghurt	0.2093 0.6475014
Residuals	

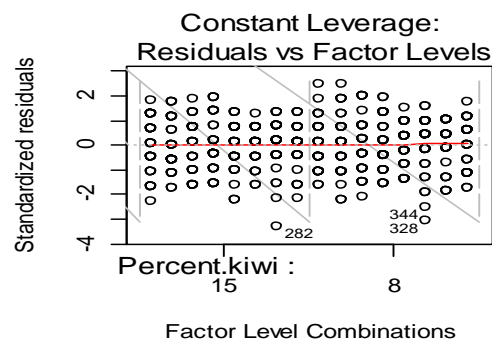
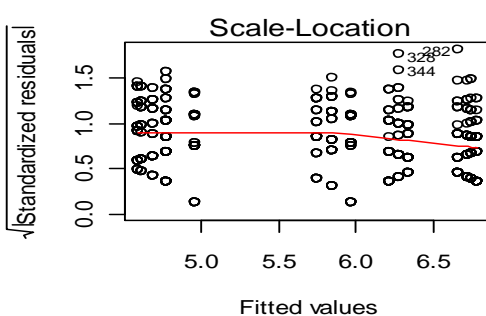
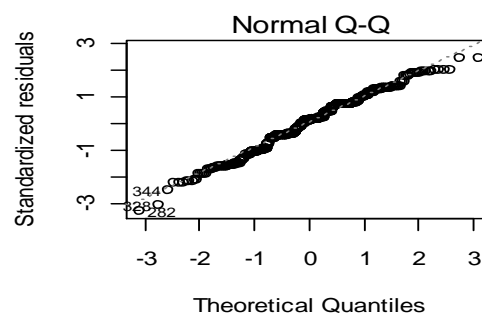
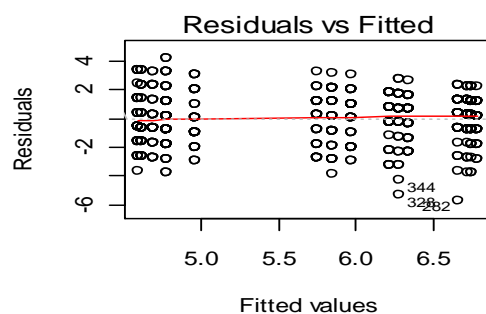
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```
oldpar<-par(oma=c(0,0,3,0),mfrow=c(2,2))
```

```
plot(design.aov)
```

```
par(oldpar)
```

```
sponse ~ Percent.kiwi * Percent.water * Percent.sugar * Ratio.yog
```



>

```
design.aov<-aov(response~Percent.water*Percent.sugar*Ratio.yoghurt*Percent.kiwi,data=design
)
```

```
> summary(design.aov)
```

	Df	Sum Sq	Mean Sq
Percent.water	1	273.20	273.195
Percent.sugar	1	3.45	3.445
Ratio.yoghurt	1	9.03	9.031
Percent.kiwi	1	39.38	39.383
Percent.water:Percent.sugar	1	0.03	0.031
Percent.water:Ratio.yoghurt	1	5.70	5.695
Percent.sugar:Ratio.yoghurt	1	0.20	0.195
Percent.water:Percent.kiwi	1	0.13	0.125
Percent.sugar:Percent.kiwi	1	0.03	0.031
Ratio.yoghurt:Percent.kiwi	1	5.70	5.695
Percent.water:Percent.sugar:Ratio.yoghurt	1	0.00	0.000
Percent.water:Percent.sugar:Percent.kiwi	1	0.38	0.383
Percent.water:Ratio.yoghurt:Percent.kiwi	1	12.50	12.500
Percent.sugar:Ratio.yoghurt:Percent.kiwi	1	0.03	0.031
Percent.water:Percent.sugar:Ratio.yoghurt:Percent.kiwi	1	0.63	0.633
Residuals	496	1499.50	3.023

	F value	Pr(>F)
Percent.water	90.3667	< 2.2e-16 ***
Percent.sugar	1.1396	0.2862499
Ratio.yoghurt	2.9873	0.0845408 .
Percent.kiwi	13.0269	0.0003382 ***
Percent.water:Percent.sugar	0.0103	0.9190597
Percent.water:Ratio.yoghurt	1.8839	0.1705144
Percent.sugar:Ratio.yoghurt	0.0646	0.7994658
Percent.water:Percent.kiwi	0.0413	0.8389528
Percent.sugar:Percent.kiwi	0.0103	0.9190597
Ratio.yoghurt:Percent.kiwi	1.8839	0.1705144
Percent.water:Percent.sugar:Ratio.yoghurt	0.0000	1.0000000
Percent.water:Percent.sugar:Percent.kiwi	0.1266	0.7221081
Percent.water:Ratio.yoghurt:Percent.kiwi	4.1347	0.0425441 *
Percent.sugar:Ratio.yoghurt:Percent.kiwi	0.0103	0.9190597
Percent.water:Percent.sugar:Ratio.yoghurt:Percent.kiwi	0.2093	0.6475014
Residuals		

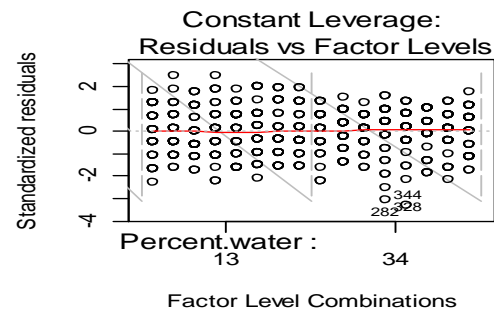
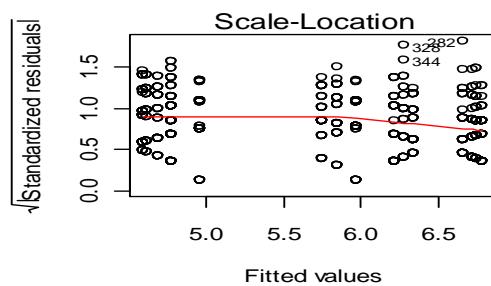
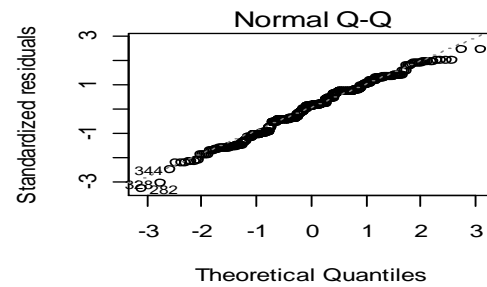
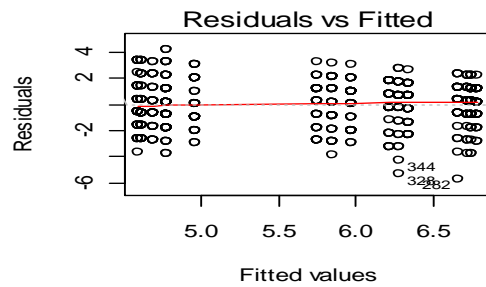
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```
> oldpar<-par(oma=c(0,0,3,0),mfrow=c(2,2))
```

```
> plot(design.aov)
```

```
> par(oldpar)
```


sponse ~ Percent.water * Percent.sugar * Ratio.yoghurt * Percent.



```
> library(rsm)
```

```
> design.rsm<-data.frame(Percent.sugar,Percent.kiwi,Percent.water,Ratio.yoghurt,response)
```

```
>
```

```
design.CR<-coded.data(design.rsm,x1~(Percent.sugar-10.5)/4.5,x2~(Percent.kiwi-11.5)/3.5,x3~(Percent.water-23.5)/10.5,x4~(Ratio.yoghurt-21.85)/14.65)
```

```
> design.CR
```

	x1	x2	x3	x4	response
1	-1	-1	-1	-1	5
2	-1	-1	1	-1	8
3	-1	1	-1	-1	5
4	-1	1	1	-1	6
5	-1	-1	-1	1	5
6	-1	-1	1	1	6
7	-1	1	-1	1	3
8	-1	1	1	1	3
9	1	-1	-1	-1	3
10	1	-1	1	-1	7
11	1	1	-1	-1	3
12	1	1	1	-1	8
13	1	-1	-1	1	3
14	1	-1	1	1	6
15	1	1	-1	1	6
16	1	1	1	1	8
17	-1	-1	-1	-1	3
18	-1	-1	1	-1	8

19	-1	1	-1	-1	6
20	-1	1	1	-1	7
21	-1	-1	-1	1	5
22	-1	-1	1	1	7
23	-1	1	-1	1	3
24	-1	1	1	1	7
25	1	-1	-1	-1	6
26	1	-1	1	-1	7
27	1	1	-1	-1	2
28	1	1	1	-1	6
29	1	-1	-1	1	4
30	1	-1	1	1	7
31	1	1	-1	1	7
32	1	1	1	1	4
33	-1	-1	-1	-1	7
34	-1	-1	1	-1	8
35	-1	1	-1	-1	6
36	-1	1	1	-1	8
37	-1	-1	-1	1	7
38	-1	-1	1	1	6
39	-1	1	-1	1	4
40	-1	1	1	1	4
41	1	-1	-1	-1	8
42	1	-1	1	-1	8
43	1	1	-1	-1	7
44	1	1	1	-1	8
45	1	-1	-1	1	4
46	1	-1	1	1	8
47	1	1	-1	1	7
48	1	1	1	1	8
49	-1	-1	-1	-1	5
50	-1	-1	1	-1	9
51	-1	1	-1	-1	4
52	-1	1	1	-1	8
53	-1	-1	-1	1	3
54	-1	-1	1	1	7
55	-1	1	-1	1	9
56	-1	1	1	1	5
57	1	-1	-1	-1	7
58	1	-1	1	-1	7
59	1	1	-1	-1	4
60	1	1	1	-1	8
61	1	-1	-1	1	7
62	1	-1	1	1	9

63	1	1-1	1	4
64	1	1	1 1	5
65	-1-1	-1-1		7
66	-1-1	1-1		8
67	-1	1-1-1		5
68	-1	1	1-1	7
69	-1-1	-1	1	6
70	-1-1	1	1	8
71	-1	1-1	1	4
72	-1	1	1 1	6
73	1-1	-1-1		5
74	1-1	1-1		8
75	1	1-1-1		5
76	1	1	1-1	7
77	1-1	-1	1	5
78	1-1	1	1	8
79	1	1-1	1	5
80	1	1	1 1	8
81	-1-1	-1-1		4
82	-1-1	1-1		6
83	-1	1-1-1		4
84	-1	1	1-1	7
85	-1-1	-1	1	2
86	-1-1	1	1	5
87	-1	1-1	1	3
88	-1	1	1 1	7
89	1-1	-1-1		4
90	1-1	1-1		7
91	1	1-1-1		2
92	1	1	1-1	4
93	1-1	-1	1	4
94	1-1	1	1	6
95	1	1-1	1	4
96	1	1	1 1	5
97	-1-1	-1-1		8
98	-1-1	1-1		9
99	-1	1-1-1		7
100	-1	1	1-1	8
101	-1-1	-1	1	7
102	-1-1	1	1	9
103	-1	1-1	1	8
104	-1	1	1 1	8
105	1-1	-1-1		7
106	1-1	1-1		9

107	1	1	-1	-1	8
108	1	1	1	-1	8
109	1	-1	-1	1	7
110	1	-1	1	1	9
111	1	1	-1	1	8
112	1	1	1	1	9
113	-1	-1	-1	-1	8
114	-1	-1	1	-1	8
115	-1	1	-1	-1	6
116	-1	1	1	-1	6
117	-1	-1	-1	1	4
118	-1	-1	1	1	8
119	-1	1	-1	1	5
120	-1	1	1	1	5
121	1	-1	-1	-1	7
122	1	-1	1	-1	7
123	1	1	-1	-1	6
124	1	1	1	-1	4
125	1	-1	-1	1	5
126	1	-1	1	1	7
127	1	1	-1	1	4
128	1	1	1	1	4
129	-1	-1	-1	-1	3
130	-1	-1	1	-1	6
131	-1	1	-1	-1	4
132	-1	1	1	-1	7
133	-1	-1	-1	1	4
134	-1	-1	1	1	6
135	-1	1	-1	1	3
136	-1	1	1	1	6
137	1	-1	-1	-1	5
138	1	-1	1	-1	6
139	1	1	-1	-1	6
140	1	1	1	-1	7
141	1	-1	-1	1	3
142	1	-1	1	1	6
143	1	1	-1	1	4
144	1	1	1	1	4
145	-1	-1	-1	-1	6
146	-1	-1	1	-1	6
147	-1	1	-1	-1	6
148	-1	1	1	-1	5
149	-1	-1	-1	1	6
150	-1	-1	1	1	5

151	-1	1	-1	1	4
152	-1	1	1	1	7
153	1	-1	-1	-1	6
154	1	-1	1	-1	6
155	1	1	-1	-1	6
156	1	1	1	-1	6
157	1	-1	-1	1	4
158	1	-1	1	1	7
159	1	1	-1	1	7
160	1	1	1	1	4
161	-1	-1	-1	-1	7
162	-1	-1	1	-1	8
163	-1	1	-1	-1	6
164	-1	1	1	-1	8
165	-1	-1	-1	1	7
166	-1	-1	1	1	7
167	-1	1	-1	1	3
168	-1	1	1	1	7
169	1	-1	-1	-1	6
170	1	-1	1	-1	8
171	1	1	-1	-1	4
172	1	1	1	-1	7
173	1	-1	-1	1	7
174	1	-1	1	1	8
175	1	1	-1	1	5
176	1	1	1	1	6
177	-1	-1	-1	-1	8
178	-1	-1	1	-1	3
179	-1	1	-1	-1	5
180	-1	1	1	-1	6
181	-1	-1	-1	1	4
182	-1	-1	1	1	4
183	-1	1	-1	1	6
184	-1	1	1	1	6
185	1	-1	-1	-1	6
186	1	-1	1	-1	5
187	1	1	-1	-1	4
188	1	1	1	-1	3
189	1	-1	-1	1	2
190	1	-1	1	1	3
191	1	1	-1	1	2
192	1	1	1	1	3
193	-1	-1	-1	-1	8
194	-1	-1	1	-1	6

195 -1 1 -1 -1	5
196 -1 1 1 -1	6
197 -1 -1 -1 1	5
198 -1 -1 1 1	8
199 -1 1 -1 1	5
200 -1 1 1 1	7
201 1 -1 -1 -1	7
202 1 -1 1 -1	7
203 1 1 -1 -1	6
204 1 1 1 -1	6
205 1 -1 -1 1	6
206 1 -1 1 1	7
207 1 1 -1 1	5
208 1 1 1 1	7
209 -1 -1 -1 -1	5
210 -1 -1 1 -1	5
211 -1 1 -1 -1	3
212 -1 1 1 -1	4
213 -1 -1 -1 1	4
214 -1 -1 1 1	7
215 -1 1 -1 1	1
216 -1 1 1 1	6
217 1 -1 -1 -1	5
218 1 -1 1 -1	4
219 1 1 -1 -1	1
220 1 1 1 -1	6
221 1 -1 -1 1	2
222 1 -1 1 1	4
223 1 1 -1 1	3
224 1 1 1 1	6
225 -1 -1 -1 -1	7
226 -1 -1 1 -1	6
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231 -1 1 -1 1	4
232 -1 1 1 1	7
233 1 -1 -1 -1	3
234 1 -1 1 -1	6
235 1 1 -1 -1	4
236 1 1 1 -1	3
237 1 -1 -1 1	2
238 1 -1 1 1	6

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241	-1	-1	-1	-1	9
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244	-1	1	1	-1	8
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265	1	-1	-1	-1	8
266	1	-1	1	-1	6
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269	1	-1	-1	1	7
270	1	-1	1	1	7
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272	1	1	1	1	7
273	-1	-1	-1	-1	5
274	-1	-1	1	-1	3
275	-1	1	-1	-1	3
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277	-1	-1	-1	1	3
278	-1	-1	1	1	7
279	-1	1	-1	1	1
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281	1	-1	-1	-1	3
282	1	-1	1	-1	1

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288	1	1	1	1	4
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319	1	1	-1	1	2
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330	1	-1	1	-1	6
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394 1 -1 1 -1	8
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408 -1 1 1 1	7
409 1 -1 -1 -1	7
410 1 -1 1 -1	7
411 1 1 -1 -1	6
412 1 1 1 -1	7
413 1 -1 -1 1	4
414 1 -1 1 1	7

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417	-1	-1	-1	-1	8
418	-1	-1	1	-1	9
419	-1	1	-1	-1	3
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509	1	-1	-1	1	4
510	1	-1	1	1	8
511	1	1	-1	1	3
512	1	1	1	1	7

Variable codings ...

$x1 \sim (\text{Percent.sugar} - 10.5)/4.5$

$x2 \sim (\text{Percent.kiwi} - 11.5)/3.5$

$x3 \sim (\text{Percent.water} - 23.5)/10.5$

$x4 \sim (\text{Ratio.yoghurt} - 21.85)/14.65$

>

```
design.rs1<-rsm(response~FO(sugar,kiwi,water,yoghurt)+TWI(sugar,kiwi,water,yoghurt),data=design.CR)
```

```
> summary(design.rs1)
```

Call:

```
rsm(formula = response ~ FO(sugar, kiwi, water, yoghurt) + TWI(sugar, kiwi, water, yoghurt), data = design.CR)
```

Residuals:

	Min	1Q	Median	3Q	Max
	-5.8125	-1.0547	0.1875	1.2969	4.3047

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	5.734375	0.076802	74.664	< 2e-16 ***
sugar	-0.082031	0.076802	-1.068	0.285995
kiwi	-0.277344	0.076802	-3.611	0.000336 ***
water	0.730469	0.076802	9.511	< 2e-16 ***
yoghurt	-0.132813	0.076802	-1.729	0.084374 .
sugar:kiwi	-0.007812	0.076802	-0.102	0.919018
sugar:water	0.007813	0.076802	0.102	0.919018
sugar:yoghurt	-0.019531	0.076802	-0.254	0.799363
kiwi:water	0.015625	0.076802	0.203	0.838870
kiwi:yoghurt	0.105469	0.076802	1.373	0.170287
water:yoghurt	0.105469	0.076802	1.373	0.170287

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.738 on 501 degrees of freedom

Multiple R-squared: 0.1821, Adjusted R-squared: 0.1658

F-statistic: 11.15 on 10 and 501 DF, p-value: < 2.2e-16

Analysis of Variance Table

Response: response

		Df	Sum Sq	Mean Sq	F value	Pr(>F)
FO(sugar, kiwi, water, yoghurt)	4	325.05	81.264	26.9080	<2e-16	
TWI(sugar, kiwi, water, yoghurt)	6	11.77	1.962	0.6497	0.6904	
Residuals		501	1513.05	3.020		
Lack of fit	5	13.55	2.709	0.8962	0.4833	
Pure error	496	1499.50	3.023			

Stationary point of response surface:

sugar	kiwi	water	yoghurt
-57.627321	-8.142573	-1.269894	-1.450928

Stationary point in original units:

Percent.sugar	Percent.kiwi	Percent.water	Ratio.yoghurt
-248.8229443	-16.9990053	10.1661141	0.5938992

Eigenanalysis:

\$values

[1] 0.079161985 0.002925577 -0.010604212 -0.071483350

\$vectors

	[,1]	[,2]	[,3]	[,4]
[1,]	0.08534581	0.883263498	-0.45013843	-0.09968491
[2,]	-0.51289730	-0.239735717	-0.67304385	0.47589403
[3,]	-0.50523109	0.402883648	0.58665134	0.48812551
[4,]	-0.68876266	-0.007559504	0.01508566	-0.72479051

```
> design.rs1 <- rsm(response ~ FO(sugar,kiwi,water,yoghurt), data=design.CR)
> summary (design.rs1)
```

Call:

rsm(formula = response ~ FO(sugar, kiwi, water, yoghurt), data = design.CR)

Residuals:

Min	1Q	Median	3Q	Max
-5.793	-1.230	0.207	1.309	4.324

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	5.73437	0.07664	74.820	< 2e-16 ***
sugar	-0.08203	0.07664	-1.070	0.284990
kiwi	-0.27734	0.07664	-3.619	0.000326 ***
water	0.73047	0.07664	9.531	< 2e-16 ***
yoghurt	-0.13281	0.07664	-1.733	0.083725 .

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.734 on 507 degrees of freedom

Multiple R-squared: 0.1757, Adjusted R-squared: 0.1692

F-statistic: 27.02 on 4 and 507 DF, p-value: < 2.2e-16

Analysis of Variance Table

Response: response

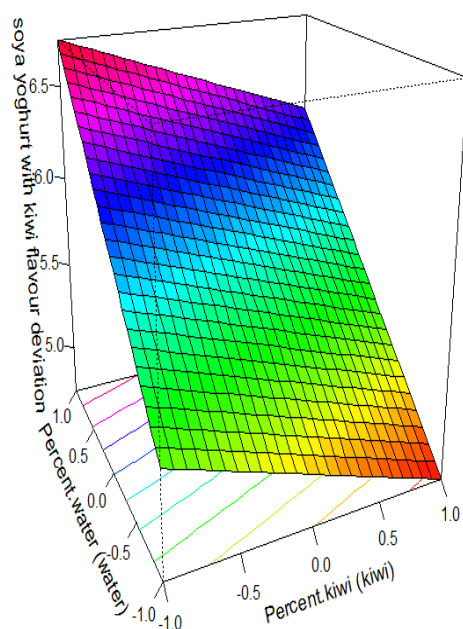
	Df	Sum Sq	Mean Sq	F value	Pr(>F)
FO(sugar, kiwi, water, yoghurt)	4	325.05	81.264	27.0200	<2e-16
Residuals	507	1524.82	3.008		
Lack of fit	11	25.32	2.302	0.7614	0.6789
Pure error	496	1499.50	3.023		

Direction of steepest ascent (at radius 1):

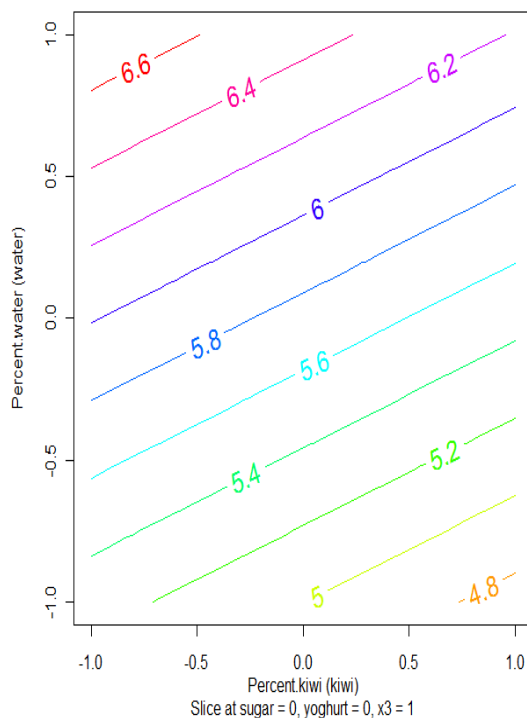
sugar	kiwi	water	yoghurt
-0.1029523	-0.3480769	0.9167658	-0.1666847

Corresponding increment in original units:

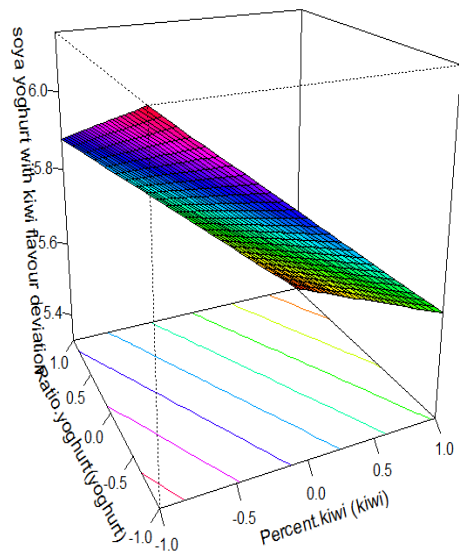
Percent.sugar	Percent.kiwi	Percent.water	Ratio.yoghurt
-0.4632854	-1.2182690	9.6260409	-2.4419307



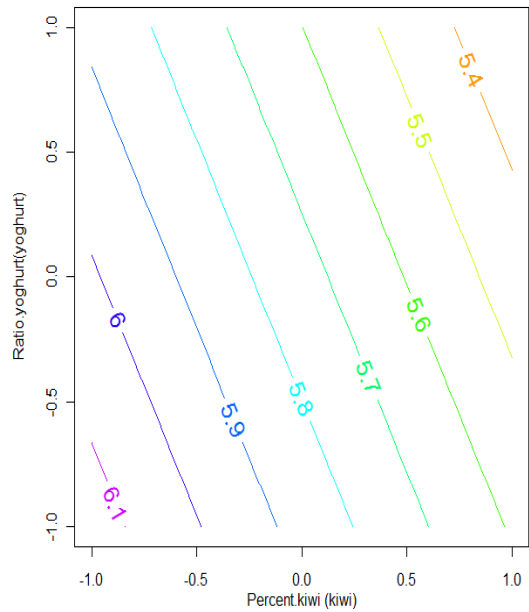
Slice at sugar = 0, yoghurt = 0, x2 = 1



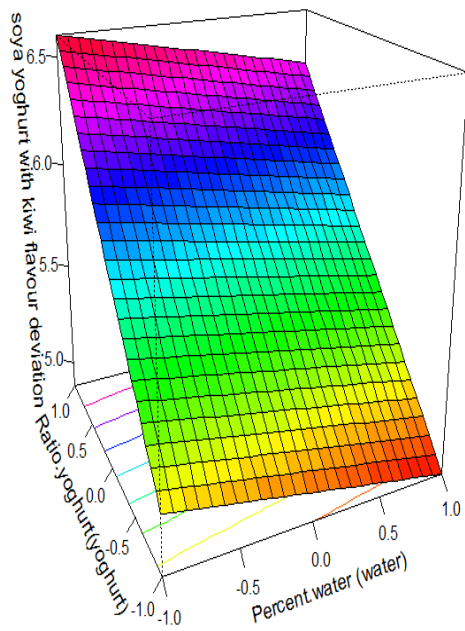
Slice at sugar = 0, yoghurt = 0, x3 = 1



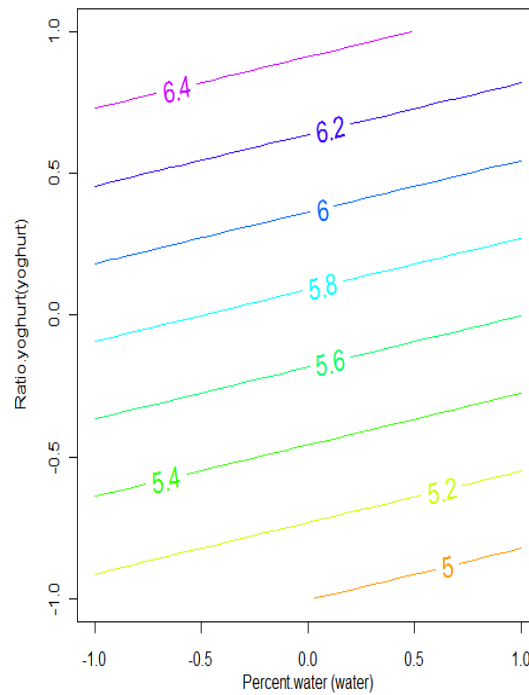
Slice at sugar = 0, water = 0, x3 = 1



Slice at sugar = 0, water = 0, x3 = 1



Slice at sugar = 0, kiwi = 0, x3 = 1



Slice at sugar = 0, kiwi = 0, x3 = 1